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Inter- and intraexaminer reliability of the Blair protractoview method: examination of a chiropractic radiographic technique

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Abstract

Objective: The purpose of this study was to evaluate the inter- and intraexaminer reliability of the Blair protractoview radiographic method.

Methods: This retrospective study evaluated 25 participants attending a Blair technique seminar. Participants included chiropractic students and doctors of chiropractic with more than 11 years of experience. Participants evaluated 100 Blair protractoview radiographs (oblique nasium). A κ analysis was used to determine the inter- and intraexaminer reliability because of the nominal categorical value of the variables. For the interexaminer reliability, a κ score was given for each examiner combination. The scores were then averaged to give the total interexaminer reliability.

Results: The overall interexaminer reliability showed substantial reliability at 0.62. Within-group κ values were as follows: no certification = 0.61, proficiency = 0.66, primary level = 0.61, and advanced level = 0.74. The overall intraexaminer reliability showed outstanding reliability at 0.81. Within-group κ values were as follows: no certification = 0.76, proficiency = 0.84, primary level = 0.82, and advanced level = 0.92. All κ values had a P value < .001.

Conclusion: The participants in this study showed good inter- and intraexaminer reliability using the Blair protractoview radiographic method.

Introduction

Some doctors of chiropractic (DCs) practice using the theory that spinal misalignments or dysfunctions may occur and that these misalignments may affect the

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function of the nervous system.[1,2] Static and functional radiographic analysis is sometimes used by chiropractors to detect spinal misalignment.[2,3] However, questions about the reliability and validity of radiographic analysis as an indicator for spinal misalignment have been raised; and studies have been completed in an effort to establish the inter- and intraexaminer reliability of various cervical radiographic analysis systems.[4,5]

The Blair Upper Cervical Chiropractic Technique is one system that uses radiographic analysis to try to determine spinal misalignment. It is based on the premise that naturally occurring asymmetry in the cervical spine would lead to error in size comparison of the left and right spinal structures, like point analysis and other line-drawing analysis used to determine a segmental misalignment.[6-8]

Blair theorized that if a misalignment of a joint occurs at the articulation, diagnostic imaging of the joint should allow visualization of the misalignment. This follows the premise that a joint should be properly juxtaposed when no misalignment is present.[9] Blair proposed that imaging the spinal joint would remove the error of asymmetry in the body. The Blair radiographic analysis is based on the presumption that the lateral edge of the occipitoatlantal (OA) articulation, 90° to the occipital convergence angle, would be seen as mirror images of one another on the 2-dimensional radiograph image.[10] To see this part of the OA articulation clearly, Blair tailored the oblique nasium radiographic view so that the diagnostic image's central ray would be in line with the occipital condyle convergence angle of the patient. This is called the *Blair protractoview* (PV).

The occipital condyle convergence angles used for the PV are measured on the base posterior radiograph. Blair theorized that when bisected in half along the longest longitudinal axis, the convergence angle of the right and left individual OA articulation could be determined (Fig 1). From this angle, Blair believed that if a patient was rotated to match the convergence angle during an oblique nasium radiograph, then a PV could be taken that would show the lateral edge of the lateral mass/occipital condyle articulation and

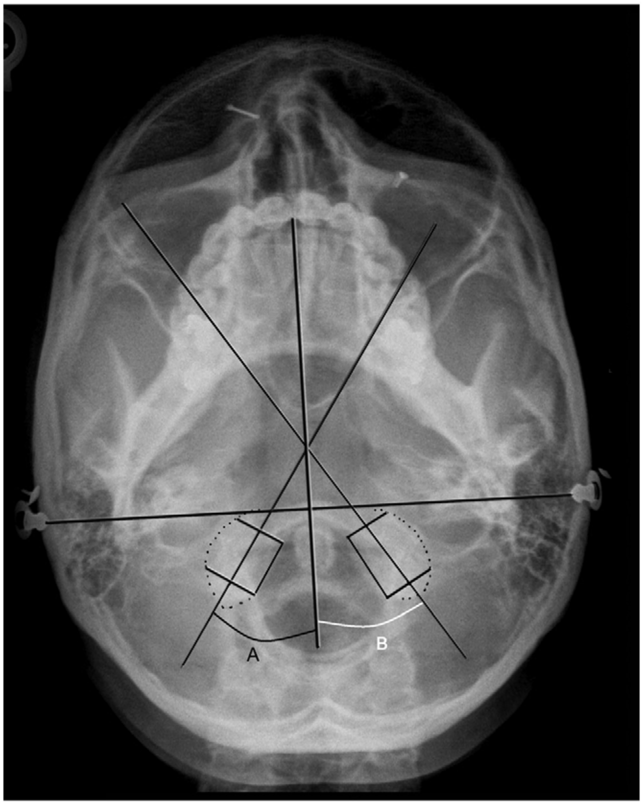

Fig 1. A base posterior radiograph. Leaded ear plugs are placed in the patient's external auditory meatus allowing for the creation of an earplug line. A sagittal line is then drawn perpendicular to the earplug line, allowing a reference to the occipital condyle angle. The left and right OA articulation is outlined, and the convergence angle of each articulation is drawn down the long axis of the joint. A, The right convergence angle. B, The left convergence angle.

Fig 2. The left PV showing an overlap at the OA articulation. This is labeled as an atlas misalignment that has occurred ASL. The white arrow represents the most lateral edge of the occipital condyle, and the black arrow represents the most lateral edge of the lateral mass of atlas.

therefore demonstrate the position of the articulating structures. Blair theorized that when a misalignment of the OA joint occurs, the atlas lateral mass travels (eg, anterior or posterior) along the longitudinal articular axis of the corresponding occipital condyle. It is theorized that the partner lateral mass travels obliquely across the longitudinal articular axis of the corresponding occipital condyle. This would result in a longitudinal misalignment in a plane parallel to the longitudinal axis of the opposite articulation. Another premise of the Blair technique is that if atlas is misaligned anterior to the occipital condyle, the lateral edge of the lateral mass will appear as an overlap or lateral to the condyle on the PV (Fig 2). If the atlas has misaligned posterior to the occipital condyle, then the lateral edge of the lateral mass will appear as an underlap or medial to the condyle on the PV (Fig 3). If the lateral mass and condyle are juxtaposed, then no misalignment will be seen (Fig 4).

Up to this point in time, there have been no known published inter- and intraexaminer reliability studies of this method. The purpose of this study is to investigate the inter- and intraexaminer reliability of PV analysis by chiropractic practitioners.

Fig 3. The left PV showing an underlap at the OA articulation. This is labeled as an atlas misalignment that has occurred PIR. The white arrow represents the most lateral edge of the occipital condyle, and the black arrow represents the most lateral edge of the lateral mass of atlas.

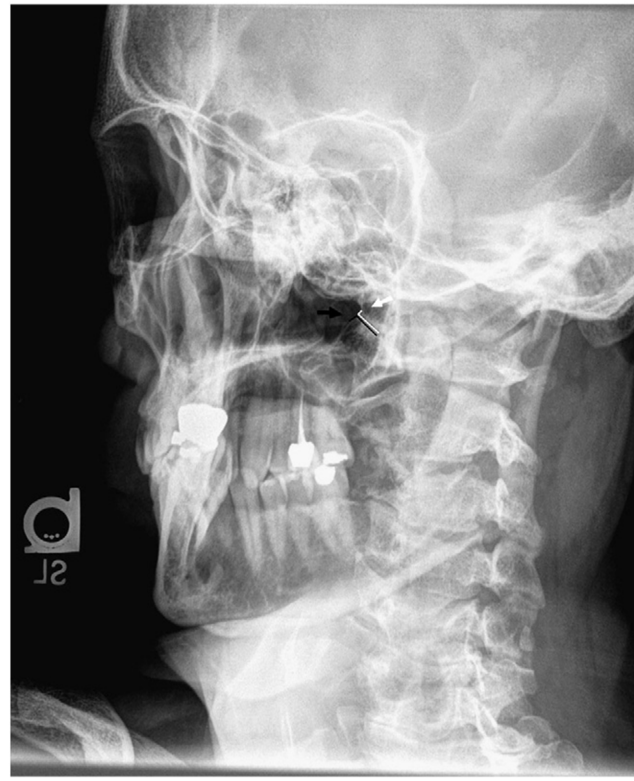

Fig 4. The left PV showing juxtaposed OA articulation. This is labeled as an even atlas alignment. The white arrow represents the most lateral edge of the occipital condyle, and the black arrow represents the most lateral edge of the lateral mass of atlas.

Methods

This is a retrospective study designed to measure the intra- and interexaminer reliability of practitioners in the determination of the direction of atlas misalignment at the OA articulation seen on Blair PV radiographs.

A convenience sample of 50 sets (right and left) of Blair PV radiographs, totaling 100 films, was selected by an independent certified Blair instructor from his clinic. The radiographs were duplicated, and all patients' identifying data were removed from the films. The radiographs were then labeled 1 to 50 and sublabeled A (left PV) or B (right PV), that is, 1A and 1B. This study was reviewed and approved by the Institutional Review Board chair of Palmer College of Chiropractic, Davenport, IA.

Exclusion criteria

Protractoviews were excluded from the study if they did not show a clear image of the OA articulation. Radiographs in which the zygomatic process or occipital shelf obscured the OA articulation were excluded. According to Blair guidelines, a PV must show an occipital condyle with a clear corner at the lateral edge of the inferior articulating surface. A PV that is not taken 90° to the convergence angle will show a rounded surface, not a "corner," at the lateral edge of the articulation surface and would have been retaken in clinical practice. All PVs for this study were viewed by an independent advanced Blair instructor and were found to be acceptable Blair PVs. The film could not be a "stereo view" that is taken to see the radiograph in 3 dimensions. Because of the lack of training by the student examiners in viewing stereo radiographs, these films were excluded from the study.

Blair PV interpretation

The Blair technique protocol instructs the DC to view the most lateral edge of the OA articulation on the Blair PV. If the most lateral edges of the occipital condyle and first cervical lateral mass are juxtaposed, there is no misalignment. If the lateral mass is further lateral than the condyle, an anterior-superior misalignment of atlas is present, toward the side of atlas laterality (left laterality on the left PV, right laterality on the right PV). If the lateral mass is medial to the condyle, a posterior-inferior atlas misalignment is present, toward the medial direction (right on the left PV, left on the right PV).

The examiners were instructed to list the misalignment finding for each PV radiograph. The possible findings on the left PV (A films) were atlas "anterior-superior-left" (ASL), atlas "posterior-inferior-right" (PIR), or "even." The possible findings on the right PV (B films) were atlas "anterior-superior-right" (ASR), atlas "posterior-inferior-left" (PIL), or "even." In this study, examiners were instructed to consider findings less than 1 mm to be "even." When analyzing the PV, no line drawing is required; the misalignment is visualized without any markings or line-drawing analysis. No pencil marks or lines were placed on the films by the principle investigator or any of the radiograph examiners. The radiographs were checked between examiners to ensure that no pencil markings were on the films.

Radiograph examiners

This study used volunteers in attendance at the 2009 Blair Chiropractic Society, Inc, annual convention. We did not handpick the examiners. Our goal for the study was to have at least 3 examiners from several chiropractic proficiency levels, from student through advanced-level certified chiropractor. The participants were volunteers from a group of attendees of the 2009 Annual Blair Conference in Atlanta, GA. The participants ranged from chiropractic students to DCs with more than 11 years of experience. This study used participants with 4 different levels of experience with the Blair technique. These were students who are currently in chiropractic school; chiropractors who have attended Blair technique seminars, but have not had any postgraduate testing; proficiency certified chiropractors who have taken a Blair technique examination; certified Blair primary instructors who have taken a Blair technique examination; and certified Blair advanced instructors. Participants were assigned an examiner number in random order. They were placed in front of a view box and given a data sheet and instructions for analyzing the PV radiographs (as listed above). The radiographs were divided into stacks of 50 (25 pairs) radiographs and placed in front of 2 separate view boxes. When a participant was finished with the first 50 radiographs, they were moved to the view box with the other 50. The participants were instructed to put each pair of radiographs (right and left PV of each patient) on the view box and list the finding on the data sheet. The participants were blinded to all patient information and to the answers of the other examiners. Each participant was asked to view all 100 radiographs (50 sets of left and right PV) twice, at 2 different times during the conference, and was asked to not discuss the film findings between analyses.

Statistical analysis

Data were analyzed using SPSS package, version 13.0 (SPSS, Inc, Chicago, IL). Each PV radiograph was analyzed independently of the other. For the left PV, the participant would determine the left OA articulation to be an ASL, PIR, or even. For the right PV, the participant would determine the right OA articulation to be an ASR, PIL, or even. An unweighted κ analysis was used to determine the inter- and intraexaminer reliability because of the nominal categorical value of the variables. The κ score was obtained by using the crosstabs option in SPSS. For the interexaminer reliability, a κ score was determined for each participant by comparing his/her answers to each of the other participant's answers for each radiograph (both first and second readings). All the scores comparing an individual participant to every other participant were then averaged together to give the overall κ score for that individual examiner. All of the overall individual participant κ scores were then averaged together to give the total interexaminer reliability. For the intraexaminer reliability, the 2 readings of the radiographs for each examiner were determined using the unweighted κ statistic. The scores for each participant were then averaged to find the overall intraexaminer κ statistic. The Blair Upper Cervical Chiropractic Society, Inc, has 4 levels of certification (none, proficient, primary-level instructor, and advanced-level instructor). Therefore, participants were grouped into certification levels. We also grouped participants into students or DCs. The κ value was considered as statistically significant if the P value was $< .05$. Determination of the level of reliability was categorized following Landis and Koch,[11] where κ values of 0.40 to 0.59 are considered moderate; 0.60 to 0.79, substantial; and 0.80 and greater, outstanding.[12] κ analysis was performed to determine the overall inter- and intraexaminer reliability of all of the participants, as well as within the 4 levels of certification within the Blair Chiropractic Society.

Results

A total of 25 participants analyzed 100 films, of whom 22 participants analyzed the films twice over the course of the conference, giving 47 readings of the radiographs. Examiners included 7 chiropractic students and 18 chiropractors. For the DCs, 7 had no level of Blair certification, 3 had proficiency certification, 4 had primary-level certification, and 4 had advanced-level Blair certification.

Interexaminer reliability

The overall interexaminer reliability for all participants showed reliability at 0.62 (Table 1). The student participants showed a κ of 0.60. The DCs had an interexaminer reliability of 0.61. Within-group κ values were as follows: no certification = 0.61, proficiency = 0.66, primary level = 0.61, and advanced level = 0.74. All κ values had a P value $< .001$.

Intraexaminer reliability

The overall intraexaminer reliability for all participants showed reliability at 0.81 (Table 1). The student participants showed a κ of 0.71. The DCs had an intraexaminer reliability of 0.84 (no certification = 0.76, proficiency = 0.84, primary level = 0.82, and advanced level = 0.92). All κ values had a P value $< .001$.

Discussion

Spinal radiographs are a fundamental element of patient spinal assessment in some chiropractic techniques.[3] The Blair Upper Cervical Chiropractic Technique uses radiographs for the determination of cervical spine segmental alignment and to determine a specific vector for spinal manipulation to the upper cervical spine. Until now, there has been no literature published in peer-reviewed journals evaluating the reliability of measuring these radiographs; and there has been only one abstract in a conference proceeding that compared the Blair technique to another upper cervical technique.[12]

This study evaluated the inter- and intraexaminer reliability for analyzing the Blair PV. The κ value for interexaminer reliability of the average participant was substantial at 0.61 (intraexaminer = 0.81), and the value for highest certified Blair chiropractors also was substantial at 0.74 (intraexaminer = 0.92). This suggests that the Blair PV may be a reliable tool for analyzing the OA articulation for misalignment/juxtaposition as defined by the Blair protocol.

The Blair radiographic analysis for the complete misalignment of a patient's first cervical vertebra is obtained when the misalignment listings from the left and right PVs are combined. This study did not combine the listings found on the left and right PVs, but looked at each view independently. Therefore, we can only determine the reliability of the PV analysis and not the analysis of the complete Blair first cervical misalignment listing. The PV is the last step of the Blair radiograph protocol for determining a misalignment of the atlas. To test the reliability of the Blair technique protocols for assessing atlas misalignment, the base posterior radiograph will need to be studied for reliability in determining the occipital convergence angles. The reliability of the combined left and right PVs listings for the patient will also need to be tested.

Chiropractors may also use palpation to determine OA misalignment. Studies have discussed palpation

Table 1 Inter- and intraexaminer reliability results of 18 chiropractors and 7 chiropractic students

Examiner	Student/ DC	Years in Practice	Certification Level	No. of Radiographs Analyzed	Overall κ		Within-Student/ DC Group Interexaminer κ	Within-Certification Group Interexaminer κ	Average Within-Certification Group κ	
					Intra	Inter			Intra	Inter
01	Student	0	NA	200	0.63	0.57	0.58	NA	NA	NA
02	Student	0	NA	200	0.69	0.55	0.58	NA	NA	NA
03	Student	0	NA	200	0.73	0.58	0.61	NA	NA	NA
04	Student	0	NA	200	0.55	0.53	0.58	NA	NA	NA
05	Student	0	NA	200	0.79	0.59	0.62	NA	NA	NA
06	Student	0	NA	200	0.85	0.60	0.61	NA	NA	NA
07	Student	0	NA	200	0.71	0.60	0.61	NA	NA	NA
08	DC	11+	None	200	0.65	0.49	0.48	0.59		
09	DC	6-10	None	200	0.81	0.58	0.59	0.63		
10	DC	11+	None	200	0.90	0.66	0.64	0.67		
11	DC	1-5	None	200	0.68	0.55	0.54	0.58		
12	DC	11+	None	100		0.60	0.58	0.58		
13	DC	1-5	None	200	0.77	0.64	0.63	0.62		
14	DC	6-10	None	100		0.66	0.65	0.62		
									0.76	0.61
15	DC	11+	Proficient	200	0.77	0.58	0.57	0.66		
16	DC	6-10	Proficient	200	0.87	0.63	0.62	0.68		
17	DC	1-5	Proficient	200	0.89	0.63	0.64	0.65		
									0.84	0.66
18	DC	11+	Primary	100		0.68	0.69	0.65		
19	DC	11+	Primary	200	0.82	0.54	0.52	0.55		
20	DC	6-10	Primary	200	0.82	0.65	0.64	0.63		
21	DC	11+	Primary	200	0.81	0.54	0.55	0.59		
									0.82	0.62
22	DC	6-10	Advanced	200	0.88	0.66	0.68	0.76		
23	DC	11+	Advanced	200	0.88	0.67	0.66	0.67		
24	DC	11+	Advanced	200	0.97	0.69	0.68	0.76		
25	DC	11+	Advanced	200	0.96	0.67	0.67	0.75		
									0.92	0.74

All κ values have a P value < .001.

of the C1 vertebra. Hart[13] reported that first cervical palpation findings matched line-drawing radiograph findings in only 16.1% of his 31 cases. Jende and Peterson[14] found that the difference in the palpated lateral prominence of the C1TP did not match first cervical laterality measurements found on radiographs. Ross et al[15] and Meseke et al[16] have questioned the interpretation of palpation findings because of asymmetry of the first cervical vertebrae. They agreed with Blair on the implication of how asymmetry of the spine may affect palpation evaluation for the spinal misalignment. Meseke et al state that "variation in the structure of the atlantoaxial joint may also lead to abnormal biomechanics related to lateral bending. These biomechanical abnormalities based on anatomical variation may be mistaken for a subluxation."[16] When palpating the atlas to determine a misalignment, the left and right transverse processes are used as references to each other. Meseke et al[16] found the mean ± SD of the atlas transverse process to be 23.06 ± 2.62 mm on the left and 23.17 ± 2.41 mm on the right. When doubling the SD, an examiner would have to account for 5-mm difference in palpation findings to account for asymmetry before determining a misalignment.

Line-drawing analysis of chiropractic radiographs are based on symmetry, which includes size comparison and like point procedures. Meseke found the mean ± SD of the width of the superior articulating surface to be 9.15 ± 1.28 mm on the left and 9.00 ± 1.29 mm on the right.[16] The width of the inferior articulating surface of the lateral mass was 13.97 ± 1.48 mm on the left and 13.91 ± 1.57 mm on the right. The height of the lateral mass was found to be 19.60 ± 2.24 mm on the left and 19.56 ± 2.09 mm on the right. Dong et al[17] found the width of the lateral mass to be 15.52 ± 1.35 mm on the left and 15.43 ± 1.06 mm on the right. Dong et al also found the lateral mass height to be 14.18 ± 1.88 mm on the left and 14.00 ± 2.03 mm on the right. Because of the standard deviation of these measurements, the left and right lateral masses were not formed as mirror images to each other. In fact, any size comparison analysis would have to be twice the SD to be considered a significant finding or interpreted as a misalignment. In the line-drawing analysis using "like points" of the spine, lines creating a wedge, which were interpreted as the presence of a misalignment, may be in fact just a difference in the height between the left and right lateral masses, occipital condyles, or both.

Briggs et al[18] studied the surface area of the occipital condyle and the corresponding lateral mass superior articulating surface. In that study, they showed that the inferior articulation surface of the occipital condyle and the superior articulation surface of the lateral mass are not mirror images of one another, which is not in dispute. This may be why Blair evaluated the lateral edge of this articulation 90° to the long axis of the occipital condyle.[10] Briggs et al[18] state that because of the asymmetry of the articulating surfaces, the analysis of an overlap/underlap seen on the PV may be due to normal anatomical variants. When testing this theory, they looked at the image mimicking a base posterior (a coronal view).It is suggested that the relationships of the condylar and lateral mass distal margins should be assessed from a diagonally vertical perspective "on a plane 90° to the long axis of the articulation."[10] Briggs et al[18] also acknowledge that "the procedures used" in their study "do not directly transfer to real-life radiographic measurements." More research needs to be done on the correlation between a misalignment seen on the PV and the status of patient health and symptoms.

When a large disagreement occurred for naming the misalignment on the PVs, the participants disagreed on the articulation being either an anterior vs even or posterior vs even. There were no radiographs that showed more than 12.8% (n = 6) disagreement between an anterior vs posterior misalignment, for example, an ASR vs a PIL. There were only 2 films that received this level of disagreement. The first film had 83% (n = 39) of the misalignment read as PIL. The second film had 80.9% agreement that the articulation was even. This would indicate that on the radiographs where there was a disagreement, it was whether there was a misalignment or not, and not disputing the direction of the misalignment, for example, an ASR vs a PIL

Limitations

Our instructions to the examiners included that misalignments less than 1 mm should be considered "even" and not be marked as an anterior or posterior misalignment. This was an attempt to express Blair clinical protocol only in adjusting the larger misalignment first. The chiropractor would then use subluxation indicators (Tyron C3000 [Titronics, Tipton, IA]; for cervical thermography, leg length inequality analysis, and spinal palpation) to determine if the patient was in need of further spinal manipulation. We did not provide the examiners with a ruler to measure the misalignment observed. We also did not allow the examiners to draw on or mark the radiographs in any way. Therefore, they had to visualize what 1 mm would be. A future study without the definition of "less than 1 mm" may show a different result.

The radiographs used in the current study were chosen as a convenience sample from a certified advanced Blair instructors' office. The Blair chiropractor, who used the exclusion criteria for this study when reviewing the radiographs, was to not include any films that did not show a clear image of the OA articulation. In the process of choosing radiographs for the study, it is possible that radiographs in which the misalignment of the OA articulation was difficult to analyze may have been excluded inadvertently. If this was the case, the reliability results in this study may be inflated, as the practitioner would not be able to handpick radiographs in his/her office. Future studies should not be predetermined "acceptable," but allow the examiners themselves to indicate if the radiograph is readable. If most or all of the examiners indicate that the radiograph is not readable, the radiograph could then be excluded from the study. Doing so would help to eliminate this bias from the exclusion process.

Between readings of the radiographs, the examiners were attending the 2009 Blair convention. Although we instructed the examiners to not discuss their findings, we cannot ensure that this was the case. Discussion of the radiographs may affect the reliability results. The 100 radiographs were separated into 2 piles of 50 radiographs each for the examiners. The order of the radiographs, however, was not shuffled between readings. There is a possibility that the examiners may have recalled their first answers to the radiographs, which could have inflated the reliability results. We tried to avoid this by including a large sample size. In the future, shuffling the order of the radiographs between examiners may help to avoid recall. Furthermore, having 2 or 3 sets of radiographs with random numbering may limit the affect of examiner recall. It could be argued that we should have used more participants. Standard reliability studies typically use 3 to 5 examiners. Choosing to use more examiners does not necessarily increase the power of the hypotheses being tested, as long as there is a sufficient amount of subjects being tested.[19]

It is also important to note that good inter- and intraexaminer reliability of a radiographic method does not necessarily imply clinical relevance. As well, this study was performed on a unique set of practitioners; and therefore, the findings for this study may not necessarily be generalized to other DCs or those who are trained in Blair methods. More inter- and intraexaminer studies need to be performed before these findings can be generalized beyond the study group.

Conclusion

Based upon the findings of this study, the participants showed good inter- and intraexaminer reliability for analyzing the Blair PV.

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Funding sources and potential conflicts of interest

Drs Hubbard and Forest are members of the Blair Upper Cervical Chiropractic Society. Drs Hubbard and Forest are Board Members and Past Presidents of this society, are Certified Advanced Instructors of Blair Upper Cervical technique, and receive income from teaching this technique. This study was done as a project for a Masters of Clinical Research program at Palmer that the first author is enrolled in at this time. No outside funding was accepted for this project.

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